Model for up-conversion luminescence in silver nanoparticles embedded erbium-doped tellurite glass

Abstract:

Nanoparticles (NPs) size dependent enhancement of the infrared-to-visible frequency up-conversion (UC) and absorption coefficient in silver NPs embedded Er3+ doped tellurite glasses on pumping with the 976 nm radiation have been investigated. The rate equations derived from the 4-level model developed by the authors earlier to discuss temperature dependent UC have now been extended to study the role played by NPs. The effects of quantum confinement and local field of silver NPs have been incorporated. Considering the spherical NPs size distribution as Gaussian, an analytical expression for the luminescence intensity and absorption coefficient has been obtained for the first time, is further exploited to examine the enhancement of UC emission intensity due to the presence of silver NPs. Furthermore, an enhancement in UC emission intensity of the green bands (2H11/2-4I15/2 and 4S3/2-4I15/2) and red band (4F9/2-4I15/2) emission of Er3+ ion at temperature 250 K and optimized Er3+ concentration 1.0 mol% have been observed up to few times in the presence of silver NPs in the glass. The green emission showed larger enhancement than the red emission. The observed of Er3+ luminescence is mainly attributed to the local field effects namely the surface plasmon resonance of silver NPs which causes an intensified electromagnetic field around NPs, resulting in enhanced optical transitions of Er3+ ions in the vicinity. The model is quite general and can be applied to other rare earth doped glasses containing metallic NPs. Our results on NPs size dependent emission intensity and absorption coefficient are in conformity with other findings. The present systematic study provides useful information for further development of UC lasers and sensors.